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DISTURBANCES IN FLOW/SURFACE NOISE
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Final Report

on

NASA Grant No. NSG 1329

The Role of Large Scale Disturbances
in Flow / Surface Noise Generation

Period covered by this project:

July 15, 1976 to March 31, 1979

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This is the final report on NASA Grant NSG 1329 which covers the period July 15, 1976 to March 31, 1979. Under the support of this grant a number of important findings have been obtained. They are reported in the following journal articles and publication.

1. Excitation of instability waves in a two dimensional shear layer by sound. Journal of Fluid Mechanics, 89, 357-371, 1978. (Tam)
2. On the tones and pressure oscillations induced by flow over rectangular cavities. Journal of Fluid Mechanics, 89, 373-399, 1978. (Tam and Block)
3. A statistical model of turbulence in two dimensional mixing layers. Journal of Fluid Mechanics, 92, 303, 1979. (Tam and Chen)
4. The radiation of sound by the instability waves of a compressible turbulent shear layer. Journal of Fluid Mechanics (under review) (Tam and Morris)
5. A large structure model of turbulence in two dimensional jets. Ph.D. Thesis, June 1979, Florida State University (Chen)

Since the completion of item (3) work has begun to develop a similar theory for round jets. The objectives are to calculate from first principle both the jet turbulence and its associated noise. This represents a complete departure from the classical jet noise theories based on Lighthill's acoustic analogy. This effort is still continuing at the present time.

The primary objectives of this project were to evaluate the importance of large flow structures as a source of noise and to develop a mathematical theory for its prediction. Thus far, all these objectives have been accomplished. Items (3) and (5) provide the first and only statistical theory of large structures in free shear flows. In recent years, there have been attempts by many investigators to study large structures by computer simulation. However, as far as is known they are incapable of accounting for the three dimensional nature of turbulence and are usually unable to predict all second order statistics associated with the large structures. In excited jets the existence of large instability waves or structures becomes more prominent. Item (1) provides a theoretical method for calculating these large scale instability waves under external forcing. Large structures are known to be powerful noise generators in supersonic flows. A theory for predicting the noise associated directly with the large structures has been developed in item (4). This theory when applied to the case of a Mach 1.5 supersonic jet gives near field noise contours and far field directivities which compare favorably with the measured results of Dr. J.C. Yu.